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UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: James Gustafson  
 Serial No.: 10/804,305  
 Filed: 3/19/2004  
 Art Unit: 2834  
 Examiner: Lam, Thanh  
 Title: FLUID-SUBMERGED ELECTRIC MOTOR

Mail Stop AF  
 Commissioner for Patents  
 P.O. Box 1450  
 Alexandria, VA 22313-1450

APPEAL BRIEF

Dear Sir:

Subsequent to the Notice of Appeal mailed to the Patent and Trademark Office on October 14, 2005, Appellant now submits its Brief. Fees in the amount of \$500.00 are paid by the attached check. If any additional fees are necessary, you are hereby authorized to charge the same deposit account number.

Real Party in Interest

The real party in interest is Hamilton Sundstrand, assignee of the present invention.

Related Appeals and Interferences

There are no related appeals or interferences.

### **Status of the Claims**

Claims 1, 4-6, and 10-23 are pending and rejected.

### **Status of Amendments**

There were no amendments after final.

### **Summary of Claimed Subject Matter**

The present invention is directed to electric starters, and more particularly to starters having electric motors. Large-scale power generators often use gas turbine engines to supply power to a geographic region. Reliable start up of these engines is critical to ensure that power outages do not occur. [see paragraph 2]

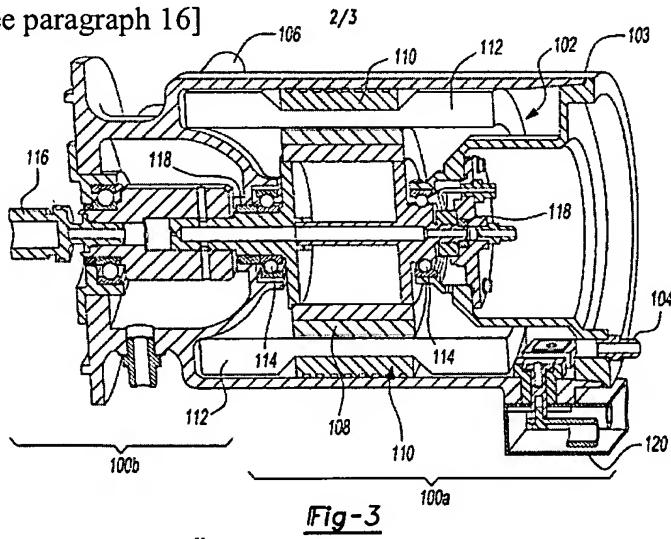
Electric starters are known for starting small engines, but the special requirements of large engines have generally made them inappropriate for use with large engines. Many gas turbines in the 20 to 50 MW range are derivatives of aircraft engines (known as "aeroderivatives") and, as such, they initially retained the lightweight, high-performance pneumatic starters from the initial design. As applications evolved, the pneumatic starters were replaced with hydraulic starters because weight is less of a concern in ground-based gas turbine engines. The next logical step is to apply electric motors to replace the hydraulic starter units. [see paragraph 3]

More particularly, electric starters rely on electric motors to convert electrical input power into mechanical power in the form of rotational torque, which in turn is used to start an engine. High-density motors produce a significant amount of heat and therefore require an effective heat dissipation mechanism to avoid overheating of the motor components. The electrical resistance of the stator winding in the motor and the fluctuating magnetic field passing through the metallic stator and rotor are both sources of much of the heat in the motor. Moreover, the size and high power density of the motor generate too much heat to be effectively

dissipated through air cooling. Liquid coolant may be used to dissipate heat, but coolant flow is typically provided by a positive displacement pump that is driven by the engine, which is in turn rotated by the starter, making the coolant unavailable during motor startup. Also, the motor torque and its associated current will be highest at startup, further aggravating the lack of heat dissipation from the motor. [see paragraph 5]

Electric motors used in close proximity to gas turbine engines must be capable of operation in an environment that may contain flammable gases. Under certain conditions, electric motors may develop hot spots and/or electrical shorts, which can increase the risks of operating electric motors in a hazardous environment. [see paragraph 6]

Figure 3 (reproduced below) shows an electric starter 100, having an electric motor 100a, such as a permanent magnet motor or switched reluctance motor, and a clutch 100b within a single package. In the embodiment shown in Figure 3, the electric motor 100a is enclosed in a fluid-filled cavity 102 of a housing 103. The cavity 102 substantially encloses the motor 100a and has a fluid inlet 104 and a fluid outlet 106 to allow the fluid held in the cavity 102 to be circulated, removed and replaced when needed. The motor 100a itself can be any electric motor. As is known in the art, the motor 100a has a rotor 108, a stator iron 110, stator windings 112, and rotor bearings 114. [see paragraph 16]



The cavity 102 can be filled with any fluid having heat conducting properties to ensure heat transfer from the motor components to the fluid. In one embodiment, the fluid is a dielectric

oil, such as some commonly used synthetic gas turbine engine oils. Other fluids having similar characteristics may also be used. [see paragraph 17]

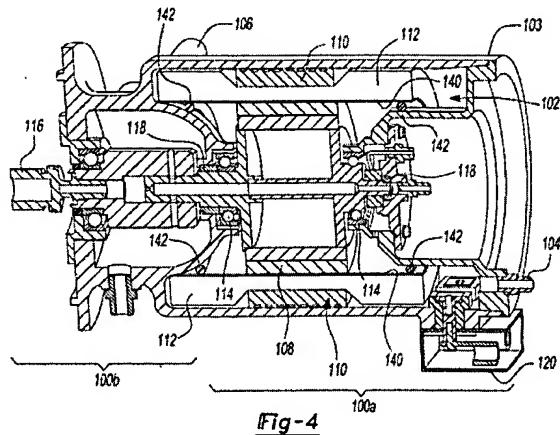
Submerging parts of the motor 100a in the fluid rather than relying on air cooling or spray cooling ensures that the fluid is in constant intimate contact with heat-generating motor components and flows over all of the surfaces of the components, greatly improving the heat transfer rate away from the components over previously-used cooling methods. [see paragraph 20]

The fluid may also have a high electrical resistance to electrically isolate the wires in the stator winding 112, preventing them from shorting to each other, to the housing, and to other motor components. A dielectric oil would have this characteristic. [see paragraph 22]

The fluid held in the cavity 102 may also act as a lubricant to lubricate the motor components, such as the rotor bearings 114. [see paragraph 23]

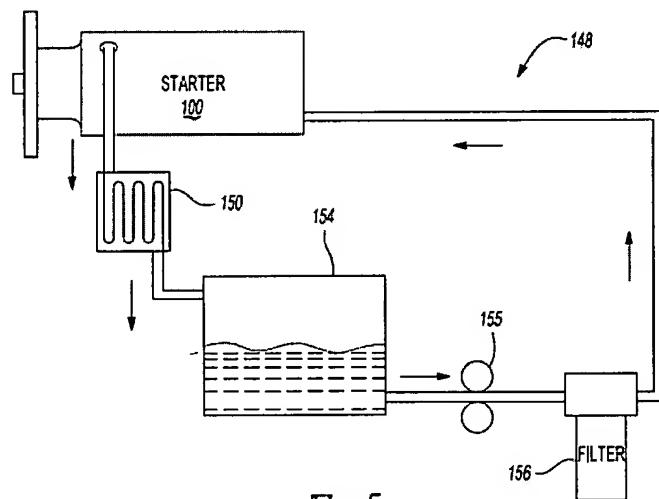
Using the same fluid for both thermal management and lubrication allows the inventive structure to solve many existing problems at once. By flooding the motor components in a cooling, lubricating fluid, such as a dielectric oil, the inventive structure can provide effective thermal management, isolate the motor from flammable gases, and provide continuous lubrication all at the same time. These features are especially effective in starter applications, where the cooling capacity is normally low if air cooling is employed. [see paragraph 24]

Figure 4 (reproduced below) illustrates an embodiment where the starter 100 is partitioned so that the rotor 108 is separated from the stator iron 110 and stator windings 112.



A can-shaped partition 140 connected to the fluid inlet 104 and the fluid outlet 106 encloses the rotor 108. The space between the outside of the partition 140 and the housing 103 forms the fluid-filled cavity 102, causing the fluid to surround only the stator components and not the rotor 108 in this embodiment. [see paragraph 25]

Referring to Figure 5 (reproduced below), the starter 100 may be one component of an overall engine starter system 148 that includes a heat exchanger 150, an external fluid reservoir 154, a fluid pump 155 and a filter 156. The fluid pump 155 circulates the fluid into the fluid inlet 104, through the cavity 102 and out of the fluid outlet 106 to remove fluid that has been heated by the motor components out of the cavity 102 and replenish the cavity with fresh fluid. [see paragraph 26]



#### Summary of Claim 1

Claim 1 recites:

1. An electric motor assembly, comprising:
  - a fluid circulation circuit;
  - a housing having a cavity that is fluidly connected to said fluid circulation circuit;
  - an electric motor having at least one electric motor component disposed in the cavity; and
  - a thermally conductive fluid for circulation through the cavity to substantially submerge said at least one electric motor component.

Referring to paragraph 16, independent Claim 1 recites an electric motor assembly 148 that comprises a fluid circulation circuit (e.g., cavity 102, inlet 104, outlet 106, Figure 5), a housing 103 having a cavity 102 that is fluidly connected to said fluid circulation circuit, an electric motor 100 having at least one electric motor component (e.g., 108, 110, 112, 114) disposed in the cavity, and a thermally conductive fluid for circulation through the cavity 102 to substantially submerge said at least one electric motor component.

Summary of Claim 20

Claim 20 recites:

20. A method of cooling and lubricating an electric motor assembly, comprising:

(1) circulating a dielectric fluid through a motor housing cavity having an electric motor disposed therein;

(2) communicating heat from the electric motor directly into the dielectric fluid;

and

(3) lubricating a moving component of the electric motor with the dielectric fluid.

Referring to paragraphs 20, 23, 24, independent claim 20 recites a method of cooling and lubricating an electric motor assembly comprising the steps of circulating a dielectric fluid through a motor housing cavity 102 having an electric motor 100 disposed therein, communicating heat from the electric motor 100 directly into the dielectric fluid, and lubricating a moving component (e.g., 114) of the electric motor 100 with the dielectric fluid.

Grounds of Rejections to Review on Appeal

1. Claims 17-19 were added in the Amendment of May 31, 2005 and were objected to under 35 U.S.C. 132(a) as introducing new matter into the disclosure. Examiner did not consider the subject matter added to the claim in making rejections based upon prior art.

2. Claims 17-19 and 23 were added in the Amendment of May 31, 2005 and are objected to under 35 U.S.C. 132(a) as introducing new matter into the disclosure.
3. Claims 1, 4-6, and 10-23 are rejected under 35 U.S.C. 102(b).

### Arguments

#### 1. Examiner Error Under 35 U.S.C. 132(a)

The Examiner objected to the Amendment filed on May 31, 2005 under 35 U.S.C. §132(a) as introducing new matter. Specifically, in the Office Action mailed on July 14, 2005 (p.1), the Examiner objected to claims 17-19 and 23 as adding material not supported by the original disclosure. However, the Examiner did not consider the subject matter of claims 17-19 (p.4) and make rejections based upon prior art as required by MPEP § 2163.06. See *In re Rasmussen*, 650 F.2d 1212, 211 USPQ 323 (CCPA 1981). MPEP § 2163.06 is reproduced in part below:

##### MPEP § 2163.06

If new matter is added to the claims, the examiner should reject the claims under 35 U.S.C. 112, first paragraph - written description requirement. *In re Rasmussen*, 650 F.2d 1212, 211 USPQ 323 (CCPA 1981). The examiner should still consider the subject matter added to the claim in making rejections based on prior art since the new matter rejection may be overcome by applicant.

In response to this error, Applicant respectfully requests prosecution to be reopened for proper consideration of claims 17-19.

## **2. New Matter Rejection Under 35 U.S.C. 132(a)**

The Examiner objected to claims 17-19 and 23 of the Amendment filed on May 31, 2005 under 35 U.S.C. §132(a) as introducing new matter. The Examiner contends that an “engine,” a “gas engine,” and “engine oil” are not supported in Applicant’s original disclosure. Applicant does not even recite a “gas engine” in the claims as the Examiner states. Claim 17 recites an engine. Claim 18 depends from claim 17 and recites engine oil. Claim 19 depends from claim 17 and recites a gas turbine engine. Claim 23 also recites an engine.

Attention is directed specifically to the Background section of the Applicant’s application. The Applicant describes start-up for gas turbine engines (paragraphs 2 and 3) and small engines (paragraph 3). Further, in the Brief Description of the Drawings section at paragraph 15, Figure 5 is described as being representative of an engine starter system. Furthermore, engine oil is referred to in paragraph 17 as commonly used synthetic gas turbine engine oil. Additionally, in paragraph 26, a starter system is referred to for an engine. There may be additional examples. These examples provide support for claims that recite an engine, a gas turbine engine, and engine oil. Accordingly, claims 17-19 and 23 contain no new matter, and Applicant respectfully requests that the objection be reversed.

## **3. Anticipation Rejection Under 35 U.S.C. §102(b)**

### **Claims 1, 4-6, and 10-23**

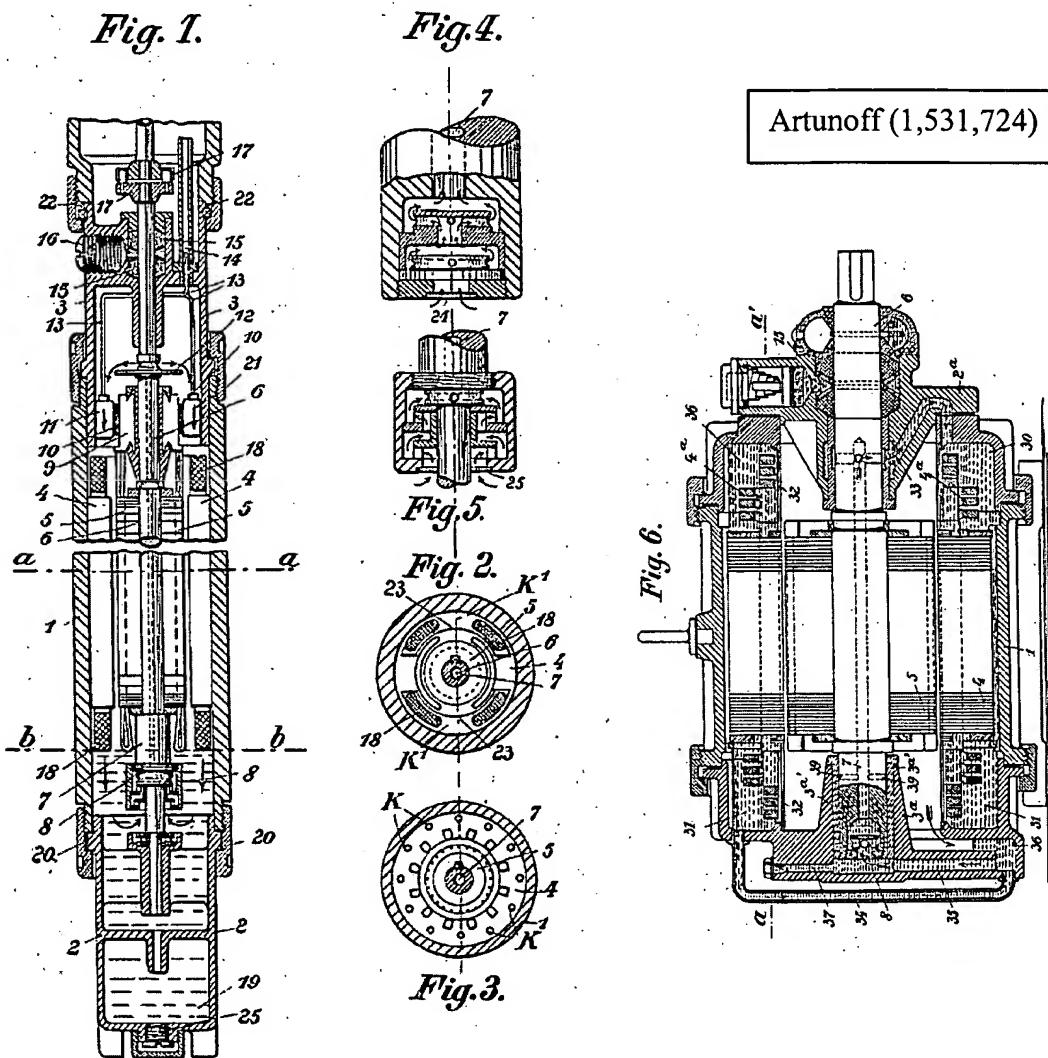
The Examiner rejected claims 1, 4-6, and 10-23 under 35 U.S.C. §102(b) as being anticipated by *Arutunoff*. Claim 1 recites a thermally conductive fluid for circulation through the

cavity to substantially submerge said at least one electric motor component. Examiner contends that the electric motor assembly of *Arutunoff* includes a fluid circulation circuit having a housing with a cavity and is fluidly connected to the fluid circulation circuit. The Examiner further states that an electric motor component 4 is disposed in the cavity and a thermally conductive fluid circulates through the cavity to substantially submerge the electric motor component 4. In general, the Examiner failed to give proper patentable weight to Applicant's claim terminology "substantially submerged."

The meaning of claim terms is to be construed in light of the intrinsic evidence, including the specification. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1316-1318 (Fed. Cir. 2005). Applicant's paragraph 17 refers to the cavity being "filled" with fluid. Paragraph 20 refers to "constant intimate contact" with fluid and paragraph 21 refers to the fluid being "constantly in contact." Thus, the term "substantially submerged" at least requires constant contact with the fluid.

The electric motor component (stator 4) of includes two sets of coils 18 (see Figures 1-6 reproduced below). The electric motor assembly of *Arutunoff* operates in a vertical position such that a lower set of coils near the line *b-b* is submerged while the upper set of coils 18 above the line *a-a* is not submerged. The upper coils 18 above line *a-a* contact fluid only when the pump operates to circulate the fluid within the motor. During operation, the fluid flows up through hollow shaft 6 and down through passages k or k' in the stator iron between the coils 18 and does not contact the stator coils. The operation is similar for the embodiment shown in Figure 6. Thus, the electric motor component (stator 4) is not in constant contact with fluid and therefore is

not “substantially submerged.” Accordingly, the rejection of claim 1 and its dependents should be reversed.



### **Claim 5**

In addition to the reasons above, *Arutunoff* does not disclose the features of claim 5. Claim 5 recites that the thermally conductive fluid is a dielectric fluid. Examiner contends that *Arutunoff* discloses a thermally conductive fluid that is a dielectric fluid. *Arutunoff* refers throughout to an internal liquid or oil, but does not disclose the use of a dielectric fluid. Indeed,

*Arutunoff* does not even mention the word “dielectric.” Applicant’s claim recites something more than just oil or internal liquid, the oil or internal liquid must have the particular feature of being a dielectric fluid. As an example of a dielectric fluid, Applicant’s paragraph 17 discloses synthetic gas turbine engine oils. *Arutunoff* fails to disclose a synthetic gas turbine engine oil and fails to disclose use of any dielectric fluid or benefit there from. A rejection based on §102(b) anticipation requires that the reference disclose all of the claimed elements. *Arutunoff* does not disclose the feature of a dielectric fluid and therefore cannot anticipate claim 5. Accordingly, the rejection of claim 5 should be reversed.

### **Claim 6**

Claim 6 depends from claim 5 and recites that the dielectric fluid is a dielectric oil. Regarding claim 6, as described above, *Arutunoff* does not disclose a dielectric fluid. Therefore, a dielectric oil as recited in claim 6 is properly allowable and the rejection should be reversed.

### **Claim 10**

In addition to the reasons above, *Arutunoff* does not disclose the features of claim 10. Claim 10 recites that the housing has a fluid inlet and a fluid outlet, and wherein the system further comprises: a fluid pump that circulates the dielectric fluid through the fluid inlet into the cavity and out of the fluid outlet. One embodiment of such an arrangement is shown in Applicant’s Figure 5 (above).

Regarding claim 10, Examiner contends that *Arutunoff* discloses that the housing has a fluid inlet and a fluid outlet for circulation of the dielectric fluid to and from a cavity. Applicant

respectfully disagrees. The electric motor of *Arutunoff* includes a housing 1 having a stopper 25 within an opening in the housing 1. The liquid circulates within the housing 1, but does not circulate into or out of the opening in the housing 1. Therefore, *Arutunoff* does not disclose a housing inlet and housing outlet for fluid circulation as recited in Applicant's claim. Accordingly, claim 10 is properly allowable and the rejection should be reversed.

### **Claim 11**

In addition to the reasons above, *Arutunoff* does not disclose the features of claim 11. Claim 11 depends from claim 1 and recites a heat exchanger in fluid communication with the dielectric fluid. Examiner contends that *Arutunoff* discloses a heat exchanger in communication with the dielectric fluid. Examiner did not point out which component in *Arutunoff* is a heat exchanger, and Applicant is unable to find any reference in to a heat exchanger or the like in the reference. Applicant's invention includes a heat exchanger separate from the motor that receives heated dielectric fluid from the motor and removes heat from the dielectric fluid before sending the fluid to a separate fluid reservoir as illustrated in the example of Applicant's Figure 5. Claim 11 is properly allowable and the rejection should be reversed.

### **Claim 12**

In addition to the reasons above, *Arutunoff* does not disclose the features of claim 12. Claim 12 depends from claim 1 and recites a filter connected upstream of the housing to filter particles from the dielectric fluid. The Examiner contends that *Arutunoff* discloses a filter connected upstream of the housing to filter particles from the dielectric fluid. Applicant

respectfully disagrees. *Arutunoff* discloses an oil filter 24 that is within the housing 1. Therefore, the oil filter 24 is not connected upstream of the housing 1, rather it is connected within the housing 1 and is neither upstream nor downstream of the housing 1. Therefore, *Arutunoff* does not disclose a filter connected upstream of the housing. Accordingly, claim 12 is properly allowable and the rejection should be reversed.

### **Claim 15**

In addition to the reasons above, *Arutunoff* does not disclose the features of claim 15. Claim 15 recites a rotor that is rotatable about a rotor axis while substantially submerged in the dielectric fluid to circulate the dielectric fluid through the cavity. The Examiner contends that *Arutunoff* discloses a rotor that is rotatable about an axis while substantially submerged in a dielectric fluid to circulate the dielectric fluid through a cavity. Applicant respectfully disagrees. In the embodiments shown in Figures 1-5 of *Arutunoff*, the oil moves through a hollow shaft 6 of the rotor and does not substantially submerge the rotor as understood from Applicant's written description (as explained above for claim 1). In the embodiment shown in Figure 6 of *Arutunoff*, the space occupied by the rotors is kept free from oil to avoid unnecessary friction between the oil and the rotor during rotor rotation. See p.4, lines 97-100. Thus, the rotor of *Arutunoff* is not substantially submerged in oil nor is it rotatable while submerged in oil as recited in Applicant's claim 15. Accordingly, claim 15 is properly allowable and the rejection should be reversed.

### **Claim 16**

In addition to the reasons above, *Arutunoff* does not disclose the features of claim 16.

Claim 16 depends from claim 1 and recites that the fluid circulation circuit includes a portion that is outside of the housing. Examiner contends that *Arutunoff* discloses a fluid circulation circuit that includes a portion that is outside of the housing. While it is well settled that terms in a claim are to be given the broadest reasonable interpretation, this interpretation must be consistent with the specification, with the claim language being read in light of the specification as will be interpreted by one of ordinary skill in the art. The housing functions to surround and contain the motor components. A portion that is outside the housing is exterior to the housing and the motor. In *Arutunoff*, the oil remains within the housing 1 and does not circulate through a fluid circulation portion that is exterior to the housing 1. Thus, even broadly construed, the interpretation that *Arutunoff* includes a portion that is outside of the housing cannot be sustained. Accordingly, claim 16 is properly allowable and the rejection should be reversed.

### Claims 20-23

In addition to the reasons above, *Arutunoff* does not disclose the features of claims 20-23.

Claim 20-23 recite a method of cooling and lubricating an electric motor assembly including the steps of circulating a dielectric fluid through a motor housing cavity having an electric motor disposed therein, communicating heat from the electric motor directly into the dielectric fluid, and lubricating a moving component of the electric motor with the dielectric fluid. Examiner contends that the apparatus of *Arutunoff* discloses the claimed method. Applicant respectfully disagrees. As described above for claims 5 and 6, *Arutunoff* does not disclose a dielectric fluid.

Therefore, *Arutunoff* cannot anticipate a method that recites a dielectric fluid. Accordingly, claims 20-23 are properly allowable and the rejection should be reversed.

**Claim 23**

In addition to the reasons above, *Arutunoff* does not disclose the features of claim 23. Claim recites circulating the dielectric fluid between the motor housing cavity and an engine and selectively operating the electric motor to drive the engine. *Arutunoff* discloses circulating a fluid within a motor housing and does not disclose circulating a dielectric fluid between a motor housing cavity and an engine as recited in Applicant's claim. For this additional reason, claim 23 is properly allowable and the rejection should be reversed.

**CLOSING**

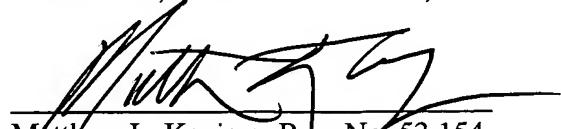
Examiner erroneously did not consider the alleged new matter when making rejections based upon the prior art. For this reason, the objection is improper and prosecution should be reopened.

The objection to claims as adding new matter was improper and must be reversed, as there is support in Applicant's disclosure for the subject matter added.

The anticipatory reference does not disclose Applicant's recited limitations and the rejections based upon the reference must therefore be reversed.

Respectfully submitted,

CARLSON, GASKEY & OLDS, P.C.

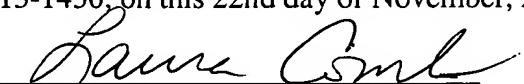


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Dated: November 22, 2005

**CERTIFICATE OF MAIL**

I hereby certify that the enclosed Response is being deposited with the United States Postal Service as First Class Mail, postage prepaid, in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 22nd day of November, 2005.

  
Laura Combs

**CLAIMS APPENDIX**

1. An electric motor assembly, comprising:
  - a fluid circulation circuit;
  - a housing having a cavity that is fluidly connected to said fluid circulation circuit;
  - an electric motor having at least one electric motor component disposed in the cavity; and
  - a thermally conductive fluid for circulation through the cavity to substantially submerge said at least one electric motor component.
4. The assembly of claim 1, wherein the housing further comprises a partition and the electric motor comprises a rotor, a stator iron, and a stator winding, the partition separating the rotor from the stator iron and the stator winding,  
wherein a space between an exterior portion of the partition and the housing forms the cavity, and wherein the thermally conductive fluid fills the cavity to substantially submerge at least one of the stator iron and the stator winding without contacting the rotor.
5. The assembly of claim 1, wherein the thermally conductive fluid is a dielectric fluid.
6. The assembly of claim 5, wherein the dielectric fluid is a dielectric oil.
10. The assembly of claim 1, wherein the housing has a fluid inlet and a fluid outlet, and wherein the system further comprises:
  - a fluid pump that circulates the dielectric fluid through the fluid inlet into the cavity and out of the fluid outlet; and
  - a fluid reservoir that houses excess dielectric fluid.
11. The assembly of claim 1, further comprising a heat exchanger in fluid communication with the dielectric fluid.

12. The assembly of claim 1, further comprising a filter connected upstream of the housing to filter particles from the dielectric fluid.
13. The assembly of claim 1, wherein said at least one electric motor component includes one of a rotor and a rotor bearing substantially submerged in said thermally conductive fluid.
14. The assembly as recited in claim 1, wherein said dielectric fluid is in fluid communication with a bearing which supports a rotor shaft.
15. The assembly of claim 1, wherein said at least one electric motor component comprises a rotor rotatable about a rotor axis, said rotor rotatable while substantially submerged in said dielectric fluid to circulate said dielectric fluid through said cavity.
16. The assembly of claim 1, wherein said fluid circulation circuit includes a portion that is outside of said housing.
17. The assembly of claim 1, wherein said electric motor includes a rotor output shaft that is coupled to an engine, said engine in fluid communication with said fluid circulation circuit.
18. The assembly of claim 17, wherein said dielectric fluid comprises engine oil received from said engine through said fluid circulation circuit.
19. The assembly of claim 17, wherein said engine comprises a gas turbine engine.
20. A method of cooling and lubricating an electric motor assembly, comprising:
  - (1) circulating a dielectric fluid through a motor housing cavity having an electric motor disposed therein;
  - (2) communicating heat from the electric motor directly into the dielectric fluid; and
  - (3) lubricating a moving component of the electric motor with the dielectric fluid.

21. The method of claim 20, wherein said step (1) further comprises directly transferring heat from a rotor bearing of the electric motor to the dielectric fluid, and said step (2) further comprises lubricating the rotor bearing with the dielectric fluid.
22. The method of claim 20, further comprising:
  - (4) rotating a component of the electric motor to circulate the dielectric fluid through the motor housing cavity.
23. The method of claim 20, wherein said step (1) further comprises circulating the dielectric fluid between the motor housing cavity and an engine and selectively operating the electric motor to drive the engine.

**EVIDENCE APPENDIX**

None.



67,010-089; H2751-ED

## **RELATED PROCEEDINGS APPENDIX**

None.